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This newsletter surveys the activities of the Committee on the Undergraduate Program in Mathematics (CUPM) and relates its history since its inception in 1953 as a standing committee on the Undergraduate Program. The responsibilities of the committee in 1953 were to make a study of the mathematics curriculum and make recommendations to the mathematical community. This issue serves to acquaint the mathematical community with some of the resulting changes in the structure and in the activities of CUPM especially as these activities relate to (1) college teachers, (2) training of elementary and secondary school teachers, (3) applications of mathematics, and (4) two-year college mathematics programs. Members of current committees are identified. Publications available from the Committee without charge are listed. (RP)

COMMITTEE ON THE UNDERGRADUATE PROGRAM IN MATHEMATICS

CUPM NEWSLETTER

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Number 2

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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May, 1968

Many tasks which CUPM undertook during its early years have been more or less completed. More recently, CUPM has attacked a number of important new problems. The purpose of this issue of the NEWSLETTER is to acquaint the mathematical community with some of the resulting changes in the structure and in the activities of CUPM.

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A SURVEY OF CUPM ACTIVITIES

EARLY HISTORY OF CUPM (1953-1965)

The history of CUPM can be traced to January, 1953 when Professor E. J. MacShane, then President of the Mathematical Association of America, appointed an ad hoc committee on the undergraduate program. A survey by this group quickly confirmed the impression that mathematics departments throughout the country were dissatisfied with the curriculum at that time. The Association therefore established a standing Committee on the Undergraduate Program (CUP) to make a study of curriculum, to experiment with curricular innovations and to make recommendations to the mathematical community. Many readers will undoubtedly recall such publications of CUP as UNIVERSAL MATHEMATICS; ELEMENTARY MATHEMATICS OF SETS WITH APPLICATIONS; MODERN MATHEMATICAL METHODS AND MODELS. It soon became apparent that the problems of modernizing undergraduate mathematics curricula were too difficult to be handled by a small committee lacking major financial resources, and so, in 1959-60, CUP was reorganized and enlarged, and immediately launched a drive to secure adequate financial support. The new group was known as the Committee on the Undergraduate Program in Mathematics (CUPM). In 1960, CUPM received substantial support from the National Science Foundation, and a large scale attack on a number of fronts was made possible.

CUPM was the first of eight national college commissions to be supported by the National Science Foundation.[1] In addition to its role as a national commission, CUPM remains a committee of the MAA and thus enjoys a number of benefits: for example, the publication facilities of two journals, the communication facilities of sectional and national meetings, and liaison with other important arms of the Association concerned with collegiate mathematics. Members of CUPM are appointed by the President of the MAA.

The early work of CUPM was carried out mainly through four panels, each of which included several members of CUPM as well as other mathematicians outside CUPM. There was one panel for each of the following areas: teacher training; physical sciences and engineering; biological, management and social sciences; pregraduate training in mathematics.

The Panel on Teacher training, working very hard, issued its first recommendations early in 1961 and launched a series of regional conferences ("Level I Conferences") dealing with the training of elementary school teachers and eventually (1966) encompassing all fifty states.[2] It is safe to say that these conferences and recommendations have brought about substantial increases in the amount of mathematics required of prospective elementary school teachers. The effect on mathematics education as a whole can only be conjectured at the present time, but there can be no doubt that this Panel deserves credit for much of CUPM's early impact upon the mathematical and educational community.

The importance of applications of mathematics was recognized by CUPM at the very beginning when the Committee formed a Panel on Mathematics for the Physical Sciences and Engineering and a Panel on Mathematics for the Biological, Management, and Social Sciences. The PSE Panel issued its recommendations for engineers and physicists (1962) and then proceeded to outline its recommendations for work in computing (1964). Meanwhile, the BMSS Panel, confronting problems less well understood, required more time and even then issued only "tentative" recommendations (1964).

Preparation for graduate study in mathematics was the concern of the Panel on Pregraduate Training. This Panel concentrated its initial efforts upon an ideal curriculum for excellently prepared students of outstanding ability. The resulting report, PREGRADUATE PREPARATION OF RESEARCH MATHEMATICIANS (1963), (known as the "dark green book" because of its cover) describes a sort of mathematical Utopia. Despite many misunderstandings, the dark green book has served effectively as a basis for discussion and planning at many institutions.

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1. Others are: Commission on Education in Agriculture and Natural Resources, Commission on Undergraduate Education in the Biological Sciences, Advisory Council on College Chemistry, Commission on Engineering Education, Commission on College Geography, Council on Education in the Geological Sciences, Commission on College Physics.
2. CUPM Report No. 15 provides a summary of these conferences.

It was immediately clear, however, that a more practicable set of recommendations would be needed for the guidance of most colleges, and so the Panel surveyed a number of graduate departments to see what they regarded as adequate preparation for the present. The consequent recommendations are formulated in the "pale green book," PREPARATION FOR GRADUATE STUDY IN MATHEMATICS (1965).

All of these Panel reports provided detailed descriptions of mathematics courses especially designed for well prepared students intending to enter various professional areas. However, it soon became apparent that only the largest or best endowed universities had the human and financial resources to implement this wide spectrum of recommended curricula. Most colleges needed help in constructing a central curriculum--one which was economical, reasonably close to the capability of the faculty, general enough to form a sound foundation for further mathematical study in diverse specialities, sufficiently flexible to allow for local adaptation, yet modern, challenging, and effective. To produce such a curriculum, Chairman William L. Duren, Jr. appointed a special subcommittee composed of members from the several specialist panels. The subcommittee included members of the School Mathematics Study Group and consulted with experts in leading universities to assure proper articulation with other levels of mathematics education. Their report, A GENERAL CURRICULUM IN MATHEMATICS FOR COLLEGES (GCMC), was referred by CUPM in August, 1965 to the full membership of the MAA in order that its proposals would receive the widest circulation and consideration.

The curriculum proposed in the GCMC report reflects self-imposed limitations which the subcommittee felt were consistent with its charge. In many ways the General Curriculum is minimal. It is designed to be taught by a college department using as few as four of its members. It does not provide for courses which are basically remedial, nor for a general cultural course in mathematics, nor for special training courses for teachers, nor for instruction in the operation of a computer. Neither does it describe an adequate honors program. It is, as it was intended to be, a spare but complete skeleton of collegiate mathematics to which each institution can add muscle and flesh according to the particular needs of its students and the special capabilities of its faculty.

CURRENT ACTIVITIES

1. College Teachers. The postwar shortage of mathematicians,[3] already severe by the late 1950's, had seriously impaired the ability of many colleges to implement the CUPM recommendations, including the proposed General Curriculum. Qualified new faculty members were extremely difficult to obtain, and many established teachers were so overloaded with teaching responsibilities that they could not keep abreast of developments in their field. Meanwhile, enrollments in mathematics, especially in advanced courses, were growing at a rate faster

3. See also CUPM Newsletter No. 1: STAFF PROBLEMS IN THE COLLEGES.

than overall college enrollments. By 1965 the time was obviously ripe for CUPM to see what could be done to alleviate the staff problem. First, an ad hoc committee was appointed to study and report on the proper academic qualifications for teaching the General Curriculum. Simultaneously, CUPM established a Panel on College Teacher Preparation, and instructed it to study a number of related topics: existing programs for the preservice and inservice training of college teachers, opportunities for support of college teacher programs by government and foundations, the supervision and training of teaching assistants, supply and demand data, etc.

In 1967, the qualifications committee published its report, QUALIFICATIONS FOR A COLLEGE FACULTY IN MATHEMATICS. The report identifies four possible components[4] in the formal education of college teachers:

(1) a strong "undergraduate" mathematics major;
(2) a "first graduate component" which introduces the student to serious graduate work in the principal disciplines of mathematics;
(3) an "advanced graduate component" which includes advanced graduate work and research seminars; and
(4) the doctoral dissertation.

It then describes teaching duties suitable for individuals with academic attainment equivalent to a given component, and it also makes suggestions concerning the composition of a small undergraduate department.

In particular, the qualifications report states that the advanced graduate component is adequate preparation for teachers in undergraduate colleges; however, it emphasizes that for continued professional competence, the teacher, no matter what degrees he may hold, must possess both the willingness and the ability to pursue his education indefinitely.[5] Thus, a doctoral degree is regarded by the committee as neither a necessary nor a sufficient credential for the fully qualified college teacher. This thesis, of course, is contrary to long professed academic principles although, in point of fact, most colleges have for a long time been employing and awarding tenure to mathematicians without doctorates. It is the hope of the qualifications committee and of CUPM itself that college administrators may judge the qualifications of their staffs not only by formal degrees held, but by actual professional competence; and that well qualified teachers without doctorates will not be treated as second class citizens in the academic community.

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4. It will be necessary to refer to the report itself for more complete descriptions of the components. In particular, (1) includes a substantial amount of advanced undergraduate mathematics which many students take in graduate school. The first graduate component (2) then builds upon (1), and the advanced graduate component (3) builds upon (2).
5. See the article, "Alternatives to Research," by D. E. Christie and J. H. Wells appearing in the AMERICAN MATHEMATICAL MONTHLY, Vol. 74, No. 8, October, 1967. (Reprints can be obtained by writing to the CUPM Central Office.)

The qualifications committee maintains that a teacher with preparation equivalent to the first graduate component is academically qualified to teach the lower division courses in the General Curriculum (these include calculus and the elements of probability and linear algebra) and possibly some of the upper division courses. Such teachers are thus qualified to teach college transfer courses at two year institutions.

The committee further asserts that graduate students who have completed the "strong mathematics major" are qualified to assist mature professors in teaching elementary courses.

Immediately upon publication of the qualifications report, the College Teacher Preparation Panel fell heir to several tasks. One of these is the responsibility for a series of regional conferences designed to bring together mathematicians and college administrators (from the same colleges) to discuss some of the issues raised by the report. Conferences have already been held in Denver, Colorado (October 13-14, 1967), in Columbia, South Carolina (February 15-16, 1968), and in Syracuse, New York (April 26-27, 1968). These conferences have been useful in providing administrators with information concerning the staff problem and some of the reasons for the shortage of PhD's. Mathematics chairmen attending the conferences have frequently found their own positions reinforced by the views of others in the presence of their administrators. It is hoped that these conferences will foster effective dialogue between mathematics departments and administrations of the colleges.

At present, the College Teacher Preparation Panel is engaged in two writing projects. One is a detailed description of a graduate program modeled after the first graduate component. While this program emphasizes those parts of graduate mathematics which are most essential for teaching lower division courses, it is not intended as a special track for graduate students who plan to enter college teaching upon completion of the first graduate component. The program will move the PhD-bound student at a normal rate toward his goal and give him valuable experience in teaching undergraduates.

The second project is a report on the supervision and training of teaching assistants in mathematics. The study was carried out during the current academic year, when information was obtained from about 150 mathematics departments in the U.S. and Canada. Response to the Panel's inquiries indicated a high degree of interest in the topic.

2. Training of Elementary and Secondary School Teachers. Of the four original CUPM panels, only the Panel on Teacher Training still exists. The 1961 report, RECOMMENDATIONS FOR THE TRAINING OF TEACHERS OF MATHEMATICS, has been reprinted several times, most recently in 1966 when it was slightly revised. The LEVEL I COURSE GUIDES have also been revised and reprinted.

The Panel is currently involved in a comprehensive assessment of the various

influences on school mathematics with a view to revising its recommendations to insure their relevance to the problems of the 1970's. Specifically, the Panel is concerned with the effects of such efforts as UICSM, the University of Maryland Mathematics Project, SMSG and the Cambridge Conferences. The growing influence of the computer provides another impetus for change.

The Panel has arranged for conferences as a method of exposing in detail the directions which these influences are taking. In October of 1967, a conference was held as a joint venture with the Panel on Computing: this conference brought together many individuals with experience and expertise on the trends in computer education or, more precisely, the computer in education. The conference revealed that courses about computers, as well as courses in which the computer serves as an educational tool, are already an important part of the mathematics program in many schools, and are fast becoming so in others. The situation nationally, however, appeared to be in a state of great flux, suggesting further study by the Panel before any specific teacher training recommendations are formulated.

A step in such further study will come as one part of a "Conference on Future Directions," to be held in June, 1968. This conference will bring together people who are working at the forefront of the changing school mathematics scene and should provide the panel with the best possible information and predictions upon which to base its revisions in the coming year.

The completion of the revised recommendations is now planned for the summer of 1969, and at that time a writing session to create new course guides is proposed.

Among the other activities planned by the panel for the coming year are:

(a) Level III and IV regional conferences;
(b) a conference on the training appropriate for mathematics supervisors;
(c) a conference on a projected "content and objectives" course, designed to explain to the prospective teacher the intellectual motivations for the new curricula.

3. Applications of Mathematics. By the fall of 1966, CUPM had already expended considerable effort toward mathematics for applications. The PSE and BMSS Panels, as well as an ad hoc Subcommittee on Applied Mathematics, had issued a number of pamphlets and monographs. (See list on page 12.) At that time it was clear that, even though some of the original problems assigned to these groups had been taken care of, new problems in these and other areas were arising. CUPM therefore formed an Advisory Group on Applications of Mathematics to survey the whole area of applications and to guide CUPM activities in this sector. The Group will keep informed on the uses of mathematics in other disciplines, the feedback to mathematics from these uses, the importance of certain special branches of mathematics in applications, and the proliferation of the uses of the computer. In this way the Group will be able

to call attention to those fields of application that should be considered or reconsidered by CUPM.

Another duty of the AGA is to publicize the last set of recommendations prepared by the PSE Panel: MATHEMATICAL ENGINEERING: A FIVE YEAR PROGRAM. A series of small regional conferences is now being held, in which engineers and mathematicians from the same universities explore jointly the problems of implementing this "Five Year Program" at their home institutions and exchange ideas with their counterparts at other universities in the vicinity. Three of these conferences on the Five Year Program have already taken place: Chicago, Illinois (November 4, 1967), San Francisco, California (January 20, 1968), and New Orleans, Louisiana (March 23, 1968).

The PSE Panel was disbanded at the time the Advisory Group was formed. Meanwhile, the BMSS Panel, which had for some time been active mainly in the field of biological and medical sciences, requested to be reorganized specifically for this kind of activity; it was replaced by a Panel on Mathematics for the Life Sciences. This group continued the close cooperation with the Commission on Undergraduate Education in the Biological Sciences (CUEBS) which had already been established. One product of this interdisciplinary venture is a collection of mathematical models in biology prepared initially at the University of Michigan under a grant from the National Institutes of Health, and revised by consultants from CUPM and CUEBS. A second edition of the collection, entitled SOME MATHEMATICAL MODELS IN BIOLOGY, appeared this winter and has been mailed to mathematics departments throughout the country.

Two new panels are just beginning their activities. A Panel on Computing is now discussing the problems generated by the introduction of computers into undergraduate mathematics courses, especially at the freshman level. A Panel on Statistics is just being organized; one major task which this Panel will undertake early is a critical examination of the basic service course in statistics; it will also study other aspects of undergraduate instruction, including preparation for graduate study in statistics.

4. Two-Year College Mathematics Programs. One of the most impressive aspects of the growth of higher education is the burgeoning of the two-year colleges. Not only are enrollments in these institutions increasing dramatically, but the number of two-year colleges in the nation is increasing at a rate of nearly one per week. Prompted by a growing concern on the part of the MAA Board of Governors, CUPM undertook in the spring of 1966 a study of the problems associated with two-year college mathematics programs. It was already clear that at least some, and perhaps most, aspects of two-year college mathematics fell within the scope of CUPM's mandate; and it quickly became clear that these institutions were anxious for guidance from CUPM.

Thus, in September, 1966 a Panel on Mathematics in Two-Year Colleges was formed. Members were initially grouped into three "subpanels," dealing with

university parallel (transfer), general education, and technical-occupational programs, respectively. The Panel and its subpanels embarked upon a period of intensive study, meeting frequently with consultants from mathematics departments and administrations of two-year colleges and from four-year colleges receiving transfer students.

After an initial year spent in information gathering and problem identification, the Panel was requested by CUPM to concentrate first upon designing a curriculum for students who will go on to complete a bachelor's degree. A study of the qualifications for teachers of this curriculum was also inaugurated, and a third group will prepare a basic library list for two-year colleges. These are areas in which CUPM has had some success in the four-year colleges and in which the special problems of two-year colleges are best understood. They do not necessarily represent the most critical problems of the two-year colleges. In order to clarify this point, it would be helpful to describe the national two-year college scene as it appears on the basis of the meetings held by the Panel with its consultants, from available studies,[6] and from members of the Panel who have taught in two-year colleges.

There are several states with only a few two-year colleges and there are several in which an extensive two-year college system forms a major segment of the overall system of higher education. The colleges themselves include some which are strictly post high school vocational training institutions, some which are purely academic, and some which concentrate on general education; but most combine these three functions in response to the needs of the communities they serve. The extreme variations in the natures of these communities are reflected in several ways in the institutions themselves: make up of student body, type of institutional control, availability of staff, access to and curricular coordination with nearby four-year colleges, to mention a few. Departments of mathematics are non-existent in some two-year colleges, but large and well staffed in others. Full and part-time staff members frequently are drawn from local high schools and from the community at large.

The preparation, abilities, motivation and educational-vocational goals of the student bodies also vary widely, not only from school to school but within individual schools. The consultants from two-year colleges were almost unanimous in observing that more than half of their teaching was devoted to general education and remedial mathematics. The CBMS survey[7] bears this out (Table B2, Entering Freshman Enrollments by Level: arithmetic 12%, high school algebra 30%, college algebra-trigonometry 44%, Analytic Geometry-Calculus 14%). CUPM is now considering what steps it can take toward solving some of the difficult problems in these important areas.

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6. See, for example, the Report of the Survey Committee of the Conference Board of the Mathematical Sciences: ASPECTS OF UNDERGRADUATE TRAINING IN THE MATHEMATICAL SCIENCES, Washington, 1967; and the National Science Foundation Report: THE JUNIOR COLLEGE AND EDUCATION IN THE SCIENCES, U. S. Government Printing Office, Washington, 1967.
7. op. cit.

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CURRENT CUPM PUBLICATIONS

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1. A General Curriculum in Mathematics for Colleges (1965)
2. Pregraduate Preparation of Research Mathematicians (Revised 1965)
3. Preparation for Graduate Study in Mathematics (1965)
4. Recommendations for the Training of Teachers of Mathematics (Revised 1966)
5. Course Guides for the Training of Teachers of Junior High and High School Mathematics (1961)
6. Course Guides for the Training of Elementary School Mathematics (Fourth Draft, 1964)
7. Report No. 15--Forty-one Conferences on the Training of Teachers of Elementary School Mathematics
8. Tentative Recommendations for the Undergraduate Mathematics Program for Students in the Biological, Management, and Social Sciences (1964)
9. Recommendations on the Undergraduate Mathematics Program for Engineers and Physicists (Revised 1967)
10. Recommendations on the Undergraduate Mathematics Program for Work in Computing (1964)
11. Mathematical Engineering: A Five Year Program (1966)
12. A Curriculum in Applied Mathematics (1966)
13. R. W. Hamming: Calculus and the Computer Revolution (1966)
14. T. E. Hull: The Numerical Integration of Ordinary Differential Equations (1966)
15. Qualifications for a College Faculty in Mathematics (1967)
16. CUPM Basic Library List (1965)
17. Report No. 16 - Proceedings of the CUPM Geometry Conference, Part I (1967)
18. Report No. 17 - Proceedings of the CUPM Geometry Conference, Part II (1967)
19. Report No. 18 - Proceedings of the CUPM Geometry Conference, Part III (1967)

CONSULTANTS BUREAU

In order to provide colleges with advice concerning mathematics curricula, CUPM operates a Consultants Bureau. There are some forty members of the Bureau, chosen for their experience, educational interests, professional specialties, and geographical location. They are available for two-day visits to colleges, junior colleges, and state departments of education. In addition to curricular matters, a consultant may discuss related topics such as library holdings, problems connected with staffing the mathematics department and sources of support for faculty development. A visit may be arranged without charge by writing to the CUPM Central Office.

The Committee on the Undergraduate Program in Mathematics is a committee of the Mathematical Association of America charged with making recommendations for the improvement of college and university mathematics curricula. Financial support for CUPM has been provided by the National Science Foundation.

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